Interview Summary	Application No.	Applicant(s)	
	10/029,174	BOIOCCHI ET AL.	
	Examiner	Art Unit	
	Steven D. Maki	1733	

All participants (applicant, applicant's representative, PTO personnel):

(1) *Steven D. Maki*. (3)*Ruby Jain*.

(2) *Larry Galvin*. (4)_____.

Date of Interview: *13 October 2005*.

Type: a)☐ Telephonic b)☐ Video Conference
c)☒ Personal [copy given to: 1)☐ applicant 2)☒ applicant's representative]

Exhibit shown or demonstration conducted: d)☐ Yes e)☒ No.
If Yes, brief description: _____.

Claim(s) discussed: *35 and 60*.

Identification of prior art discussed: *Himuro (JP 63-61606), Sasaki (JP 8-11508), Japan 912 (JP 8-197912), Kuze et al (US 5016695)*.

Agreement with respect to the claims f)☐ was reached. g)☒ was not reached. h)☐ N/A.

Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: *see attachment*.

(A fuller description, if necessary, and a copy of the amendments which the examiner agreed would render the claims allowable, if available, must be attached. Also, where no copy of the amendments that would render the claims allowable is available, a summary thereof must be attached.)

THE FORMAL WRITTEN REPLY TO THE LAST OFFICE ACTION MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a reply to the last Office action has already been filed, APPLICANT IS GIVEN ONE MONTH FROM THIS INTERVIEW DATE, OR THE MAILING DATE OF THIS INTERVIEW SUMMARY FORM, WHICHEVER IS LATER, TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW. See Summary of Record of Interview requirements on reverse side or on attached sheet.

Steven D Maki

Examiner's signature, if required

Examiner Note: You must sign this form unless it is an Attachment to a signed Office action.

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)
In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

Interview Summary Attachment

Applicant's representative provided a translation of Japan 63-61606 (Himuro) and Japan 8-11508 (Sasaki). These translations are attached to this interview summary. Applicant's representative specifically noted page 4 lines 30-35 of the translation for Japan 63-61606 (Himuro). Examiner interpreted page 4 lines 30-35 of the translation as describing a directional tread pattern as being an alternative.

Discussed terms "directional", "non-directional" and "asymmetric".

With respect to claim 60, applicant's representative argued that Sasaki does not show the central blocks of the first row being adjacent the annular projection and central blocks of the second row being adjacent the annular projection. Examiner noted that "adjacent" (a relative term) does not exclude a second annular projection between one of the rows of central blocks and the annular projection. In other words, claim 60 reads on the tread having two annular projections. As to Himuro, applicant's representative argued that Himuro's grooves are not "substantially perpendicular". Examiner noted that claim 60 does not require substantially perpendicular grooves.

With respect to claim 35, applicant's representative argues that there is no motivation to combine Himuro with Kuze and Japan 912 because it would increase noise. Examiner noted that the shoulder regions of Kuze and Japan 912 demonstrate non-directionality in that the shoulder grooves are inclined in the same direction instead of opposite direction. Examiner acknowledged that Kuze and Japan 912 are asymmetric tread patterns, but noted that that claim 35 does not require an asymmetric tread pattern and that claim 35 appears to read on using two bock rows on each side of

the annular projections. Examiner commented that applicant's arguments regarding claim 35 would be considered in light of a reading of the translation of Himuro provided by applicant's representative at the interview.

attachment to paper #101305

Patent number: JP63061606

Publication date: 1988-03-17

Inventor: HIMURO YASUO

Applicant: BRIDGESTONE CORP

Classification:

- international: B60C11/04; B60C11/11

- european:

Application number: JP19860203980 19860830

Priority number(s): JP19860203980 19860830

Details

1. Title of the Invention

Pneumatic radial tyre

2. Scope of Patent Claims

Pneumatic radial tyre which is a tyre formed by piling in sequence the carcass layer placed on the radial structure, the belt layer on the crown side of this carcass layer, and the tread, where on the treaded surface of the tread, at least 1 number 1 main groove extends in the circumferential direction at the side of the tread's central region with a pair of number 2 main grooves extending in parallel to the number 1 main groove as well as dividing the interval between this number 1 main groove and tread ends into tread's central region and both lateral regions, and with blocks separated by multiple horizontal grooves that extend at acute angles against the circumferential direction and by the groove clusters of these, and that is characterised by the adjoining block that mediates the horizontal groove at the central region and at least 1 region of both lateral regions having its portion facing the main groove being substantially linked up as an entity through the connecting portion.

3. Detailed Explanation of the Invention

[Industrial Field of Application]

This invention is related to the improvement of radial tyre, particularly relating to pneumatic radial tyre that can lower the pattern noise that occurs while travelling.

[Prior Art]

In recent high-performance tyres, steering stability and wetting property, and in particular, the draining performance during travel on wet road are given serious consideration and as shown in Figure 5, the pattern on tread T of treaded surface is formed by block 4 constructed from multiple cross grooves 3 inclined against the circumferential direction of the tyre and multiple main grooves 1 and 2 placed in the circumferential direction of the tyre, and in particular, in both the lateral regions Ts of the tyre, it is general practice in improving the steering stability to set the tyre's stiffness high in comparison to the tyre's central region Tc.

[Problem(s) that the Invention is to Solve]

In the prior tread pattern as shown in Figure 5, although wet performance particularly when travelling on wet road is shown with favourable results, there is a problem of pattern noise during travel with regard to the tread pattern formed by blocks.

In addition, in the aspect of steering stability, the total stiffness and such others of both the lateral regions Ts of the tyre are not always sufficient.

Furthermore, pattern noise during travel, is formed as the noise generated when the pattern elements such as blocks, lugs, and ribs that made up the tread pattern strike the road surface when the ground-contacting surface passes through the tread, and as the noise, or in other words the expanding and contracting waves of air, generated as the air inside the grooves separating these elements undergoes expansion and compression when (if passes through ground-contacting surface) the tread comes into contact with ground and then expands. These are repeated periodically (depends on speed) thus forming pattern noise.

This invention is arrived at as a result of investigating the above-mentioned problems that must be solved.

Consequently, the purpose of this invention is to offer a pneumatic radial tyre that can greatly improve pattern noise and steering stability without lowering the wet performance.

[Means of Solving the Problem(s)]

It is a tyre formed by piling in sequence the carcass layer placed on the radial structure, the belt layer on the crown side of this carcass layer, and the tread, where on the treaded surface of the tread, at least 1 number 1 main groove extends in the circumferential direction at the side of the tread's central region with a pair of number 2 main grooves extending in parallel to the number 1 main groove as well as dividing the interval between this number 1 main groove and tread ends into tread's central region and both lateral regions, and with blocks separated by multiple horizontal grooves that extend at acute angles against the circumferential direction and by the groove clusters of these, and characterised by adjacent block that mediates the horizontal grooves at the central region and at least 1 region of both lateral regions having its portion that faces the main groove substantially linked up as a single entity by the connecting portion.

[Operations]

This invention can greatly improve the pattern noise and steering stability without lowering the wet performance.

[Embodiment]

Figures 1 to 4 show the respective embodiments of this invention with Figure 1 being the spread-out explanatory diagram of tread illustrating embodiment 1, Figure 2 being the spread-out explanatory diagram of tread illustrating embodiment 2, Figure 3 being the spread-out explanatory diagram of tread illustrating embodiment 3, and Figure 4 being the spread-out explanatory diagram of tread illustrating embodiment 4.

In the diagrams, 'E' is respectively the pneumatic radial tyre of each of the embodiments of this invention and is constructed by piling together in sequence the carcass layer (not shown in diagram) placed in the radial structure, the belt layer (not shown in diagram) on the crown side of this carcass layer, and the tread T, where at least 1 number 1 main groove 10 that extends in the circumferential direction at the side of the central circumferential line CL of the tread is placed on the treaded surface of tread T, and between this number 1 main groove 10 and tread end S, there is placement of a

number 2 main grooves 20 that extend in parallel to number 1 main groove 10 as well as dividing both lateral regions Ts and central region Tc of the tread T, and furthermore, there is formation of block 40 which is divided by multiple horizontal grooves 30 that extend at acute angles against the circumferential direction and by the groove clusters of these.

Then in this invention, in particular, in the adjacent block 40 that mediates horizontal groove 30 at the central region Tc and at least 1 region of both lateral regions Ts, the portion divided by main groove 10 or 20 is substantially linked up as an entity by the connecting portion 50.

Explaining further, in the pneumatic radial tyre E of embodiment 1 as shown in Figure 1, at the treaded surface of tread T, there is a placement of 2 number 1 main grooves 10_1 and 10_2 that extend in the circumferential direction of the tyre at the spaces at left and right centred on the tread's central circumferential line CL, and between these respective number 1 main grooves 10_1 and 10_2 and both tread ends S at left and right, there is a placement of a pair of number 2 main grooves 20_1 and 20_2 that extend in parallel to the respective number 1 main grooves 10_1 and 10_2 and that divide both lateral regions Ts and central region Tc of the tread.

Then, the central region Tc or in other words, between the respective number 1 main grooves 10_1 and 10_2 and between the respective number 2 main grooves 20_1 and 20_2 as shown in diagram, divisions are made by multiple horizontal grooves 30_1 and 30_2 that extend at acute angles against the circumferential direction of the tyre thus forming multiple blocks 40_1 and 40_2.

Furthermore, both the lateral regions Ts are divided by multiple horizontal grooves 30_3 that extend at acute angles against the circumferential direction of the tyre forming multiple blocks 40_3.

Nevertheless, at the side of number 2 main grooves 20_1 and 20_2 of the respective horizontal grooves 30_3 as shown in the diagram, the respective blocks 40_3 do not pass through number 2 main grooves 20_1 and 20_2 but are substantially linked up as an entity by the connecting portion 50.

Moreover, although the connecting portion 50 links up all the blocks in the circumferential direction and it is preferred for the blocks to be endless, it is also possible to set up intermittently facing the circumferential direction as long as the purpose is not lost.

Although embodiment 2 shown in Figure 2 is almost of the same construction as the above-mentioned embodiment 1, but in this embodiment as shown in the diagram, there is no division by horizontal groove 30_1 and consequently, rib R is formed between the number 1 main grooves 10_1 and 10_2.

Although embodiment 3 shown in Figure 3 is almost of the same construction as the above-mentioned embodiment 2, but in this embodiment as shown in the diagram, the item that differs from embodiment 2 is the placement of comparatively narrow subgroove 60_1 in parallel to the respective main grooves 10 (number 1 main grooves 10_1 and 10_2, and number 2 main grooves 20_1 and 20_2) linking up the respective horizontal grooves 30_3 placed at both lateral regions Ts.

Although embodiment 4 shown in Figure 4 is almost of the same construction as each of the above-mentioned embodiments, but in this embodiment as shown in the diagram, the respective subgrooves 60_2 are placed in parallel to the respective main

grooves 10 between number 1 main grooves 10_1 and 10_2 and number 2 main grooves 20_1 and 20_2 and where multiple horizontal grooves 30_4 that extend at acute angles against the circumferential direction of the tyre divide the interval between the respective subgrooves 60_2 and number 2 main grooves 20_1 and 20_2 forming multiple blocks 40_4.

Furthermore, the width of the respective subgrooves 60_2 is preferred to be narrow width at a level where the groove-side walls substantially come into contact when the tyre is in contact with the ground.

In addition, sipe or cuff 70 is placed between the respective subgrooves 60_2 and number 1 main grooves 10_1 and 10_2 as shown in the diagram.

1 or at most 2 number 1 main grooves 10 are placed in straight line form facing in the circumferential direction at the side adjacent to the tread's centre, which will be at the central circumferential line CL of the tread in the case of 1 unit, and in the case of 2 units, they are placed mutually in parallel spaced a little apart.

In addition, a pair of number 2 main grooves 20 are placed at left and right in parallel to number 1 main groove 10 at positions some distance away from the tread's central region Tc and both lateral regions Ts of the tread or in other words, normally at positions of the tread that make from nearly 3 equal parts (Figures 1 to 3) to nearly 4 equal parts which is to say the positions nearly at the centre (Figure 4) of the tread's central circumferential line CL and the tread's lateral ends S.

In addition, the groove width 10w of number 1 main groove 10 and groove width 20w of number 2 main groove 20 are preferred to be formed with $10w > 20w$.

Furthermore, it is possible to set up subgroove 60_1 with a groove width that is equal to or below the groove width 20w of number 2 main groove 20 at both lateral regions Ts of the tread based on the purpose. (Figure 3)

In addition, it is also possible to use thin grooves at a level that close up when the tyre is in contact with ground for the deformation subgroove 60_2.

The horizontal grooves 30_1, 30_2, and 30_3 are placed in multiples in the circumferential direction of the tyre at prescribed intervals in a direction that cuts horizontally across the tread as described above.

The horizontal groove is placed at an acute angle against the circumferential direction of the tyre and as an example, other than the zigzag forms (herringbone pattern with opposite directions at left and right centred on number 2 main groove) shown in Figures 1 to 4, herringbone pattern centred on the tread's central region CL and such others can be considered, and it is preferred that appropriate curve is generated as required.

In addition, the portion divided by a pair of number 1 main grooves 10 can also be the rib (continuous in the circumferential direction). (Figures 2 to 4)

Furthermore, the carcass layer is formed by at least 1 sheet of ply arranged with organic fibre cords (nylon, polyester, rayon, etc) substantially at 90° against the circumferential direction of the tyre, but at most 3 sheets.

In addition, the belt layer is formed by piling multiples of the layer that has highly elastic cords such as steel and aramid arranged in shallow angles against the circumferential direction, in a manner where the cords of these layers mutually criss-crosses.

In this invention as mentioned above, tread T is divided into the 3 regions of central region Tc and the left and right lateral regions Ts, particularly facilitating the

draining effectiveness at central region Tc, and is formed by obtaining improvements to the steering stability at both lateral regions Ts.

Nevertheless, the adjacent block 40 that mediates horizontal groove 30 at central region Tc and at least 1 region of both lateral regions Ts that should reduce the pattern noise, is at its portion that faces main grooves 10 or 20, substantially linked up by connecting portion 50.

Then, the central region Tc divided by a pair of number 2 main grooves 20 is preferred to be set within the range of 30~50% of the tread width Tw.

Here, if the central region Tc is less than 30% of the tread's width Tw, the draining performance when travelling on wet road is lowered, while if exceeds 50%, the tread stiffness at both sides of the tread is lowered, and thus not preferred on the basis of steering stability and performance.

Furthermore, the negative ratio (proportion of groove region against apparent surface area of tread) of central region Tc is large compared with that of both lateral regions Ts, and it is desirable to set a preferred range of 30~60%.

Here, draining property is important with regard to offering this type of high-performance tyre for high speed, and a value below 30% is not preferred on the basis of draining performance while a value exceeding 60% is not preferred as there is pattern noise and the tread stiffness at both sides of tread is lowered.

The angle of the inclined horizontal groove 30 is preferred to be small when approaching the centre of the tyre and this preference is from the point of view of pattern noise, and the reason for not opening up to number 2 main groove 20 that divides the central region Tc is similarly the improvement of pattern noise and at the same time, the tread stiffness at both lateral region Ts is increased and the steering stability can be improved.

[Experimental Example]

In order to confirm the effectiveness of this invention, the steering stability on dry road surface, steering stability on wet road surface, and pattern noise are measured.

(Tyre specification used for the experiment)

- Tyre 1 of this invention

Construction ... tyre of embodiment 1 shown in Figure 1

- Tyre 2 of this invention

Construction ... tyre of embodiment 2 shown in Figure 2

- A prior-type tyre

Construction ... prior-type tyre shown in Figure 5

- Specifications below are in common
- Tyre size ... ... 225150 R 16
- Tread width Tw ... ... 250 mm
- Central region width Twc ... 70 mm
- Both lateral region width Tws ... 90 mm
- Main groove number 1 width 10w ... 10 mm
- Main groove number 2 width 20w ... 6 mm
- Inclined horizontal groove width 30w ... 3 ~ 5 mm
- Connecting portion width 50w ... ... 3 ~ 10 mm (tyre of this invention)

(Experimental method)

* Steering stability on dry road surface (dry steering stability)

Evaluation on the feeling of travelling on dry road surface of the circuit for 1 person with the internal tyre pressure at 2.0 kg/cm^2.

* Steering stability on wet road surface (wet steering stability)

Evaluation of the feeling when the circuit road surface is a wet surface with a water depth of 5 mm under the same conditions as described above.

* Pattern noise

Instrumental measurement and evaluation of the feeling of when travelling at speeds of 40, 60, 80, 100 km/h under the same conditions as described above.

The experimental results are indexed with 100 as the value of prior tyre with a larger value being the better.

The experimental results are as shown in Table 1.

(Space below is empty)

Table 1

	Prior Tyre	Invention Tyre 1	Invention Tyre 2
Dry steering stability performance	100	105	105
Wet steering stability performance	100	100	100
Pattern noise	100	110	115

[Effectiveness of the Invention]

As this invention is constructed as described above, the wet performance is not lowered, and pattern noise as well as steering stability can be greatly improved.

4. Brief Explanation of Drawings

Figure 1 ~ Figure 4 show the respective embodiments of this invention with Figure 1 being a spread-out explanatory diagram of tread showing embodiment 1, Figure 2 being a spread-out explanatory diagram of tread showing embodiment 2, Figure 3 being a spread-out explanatory diagram of tread showing embodiment 3, and Figure 4 being a spread-out explanatory diagram of tread showing embodiment 4, while Figure 5 is a spread-out explanatory diagram of tread of prior pneumatic radial tyre.

10...Main groove number 1
20...Main groove number 2
30...Horizontal groove
40...Block

50...Connecting portion
T...Tread
CL...Central portion of tread
Tc...Central region of tread
Ts...Both the lateral regions of tread

Agent: Yasuo Miyoshi (Lawyer)

10...Main groove number 1
20...Main groove number 2
30...Horizontal groove
40...Block
50...Connecting portion
T...Tread
CL...Central portion of tread
Tc...Central region of tread
Ts...Both the lateral regions of tread

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

attachment to paper # 101305

Patent number: JP8011508

Publication date: 1996-01-16

Inventor: SASAKI RYUICHI

Applicant: BRIDGESTONE CORP

Classification:

- international: B60C11/04; B60C11/13

- european:

Application number: JP19940148794 19940630

Priority number(s): JP19940148794 19940630

Abstract:

PURPOSE: To reduce noise with wetting resistance maintained by positioning a lag groove which classifies a land part area in the land part area without an axial inside end reaching grooves in the peripheral direction, and forming at least one of the grooves in the peripheral direction by repeating an expanding width part and a contracting width part in the peripheral direction. CONSTITUTION: Treads 1 are partitioned in a land part area 3 by grooves in the peripheral direction and both ends E of treads, and the land part area 3 is classified in the peripheral direction by lag grooves 4. The lag grooves 4 are positioned in the land part area 3 without an inside end in the axial direction reaching a main groove 21 in the peripheral direction which partitions the land part area, and at least one of the grooves in the peripheral direction is formed by repeating an expanding width part 11 and a contracting width part 12 in the peripheral direction. It is thus possible to reduce noise with wet skid properties maintained.

[Scope of claims]

[Claim 1] A pneumatic tyre where the sidewalls are connected, in a radial direction, with both ends of the cylindrical crown, with this crown having tread in contact with the road surface. There are three or fewer straight circumferential main grooves extending parallel to the tread. The tread is partitioned in a contact area by circumferential main grooves and both ends of the tread, and the contact area is divided in the circumferential direction by lug grooves. The lug grooves are positioned in the contact area without an inside end in the axial direction reaching a circumferential main groove which partitions the contact area, and at least one of the circumferential main grooves is formed by repeating a wide section and a narrow section in the circumferential direction.

[Detailed description of the invention]

[0001]

[Industrial field of use] The invention relates to a tyre that is able to maintain wet skid resistance whilst reducing noise.

[0002]

[Prior art] In recent years, particularly in the area of passenger cars, there have been advances in high performance, and, due to high level requirements for high speed and operational safety, there is a tendency towards flattened tyre section forms. It is known that, with the flattening of the tyre section, the expanded width of the tyre causes an expanded width of the tread, and, with poorer water drainage on wet roads, aquaplaning can occur at places with deep water even at relatively low speeds.

[0003] In order to improve the water drainage in the case of flat profile tyres, four or more straight circumferential main grooves are arranged on the tread whilst, simultaneously, many sloping lug grooves intersect with the circumferential main grooves, making an independent block section structure preferable for use. The negativity ratio (the ratio of the part of the groove in contact with the ground) of this kind of block type tread has comparatively good water drainage. However, when cornering, the knocking noise on the road surface when the blocks come into contact with the ground can often cause a problem.

[0004] In contrast to this, tyres exist which have both water drainage and noise characteristics, such as the example given in JP5-246214. On both sides of the tread of this tyre are many straight circumferential main grooves. Numerous sloping lug grooves extend from both sides of this tread and intersect with the aforementioned circumferential main grooves. As herringbone blocks are divided and converge at the centre of the tread, contact is made with the ground from the side at which the sloping lug grooves in the rotating direction converge.

[0005]

[Problems to be solved by the invention] With the aforementioned herringbone tread, as, during driving, the rows of circumferential blocks gradually come into contact with the ground, the sound caused by the corners of the blocks is dispersed. As there can be no change in the source of the noise, consequently there is no way in which the sound levels can be decreased. In addition to this, the worsening of the sound from the air column resonance within the straight circumferential main groove causes problems. Air column resonance is related to sudden movement caused by external friction when, during contact with the ground whilst moving, part of the groove width is in contact and part is not. High frequency vibration occurs in the groove wall (and also the wall of the contact

area), that is the circumferential main groove in contact with the ground, namely the air in the column vibrates. This resonance causes a worsening in the noise. This invention takes the above problem as an example and aims to maintain wet skid resistance whilst reducing noise.

[0006]

[Measures to solve the problems] This invention is a pneumatic tyre where the sidewalls are connected, in a radial direction, with both ends of the cylindrical crown, with this crown having tread in contact with the road surface. There are three or fewer straight circumferential main grooves extending parallel to the tread. The tread is partitioned in a contact area by circumferential main grooves and both ends of the tread, and the contact area is divided in the circumferential direction by lug grooves. The lug grooves are positioned in the contact area without an inside end in the axial direction reaching a circumferential main groove which partitions the contact area, and at least one of the circumferential main grooves is formed by repeating a wide section and a narrow section in the circumferential direction.

[0007]

[Function] The tyre tread of this invention relates to lug grooves extending into the contact area which is divided by the circumferential main grooves and both ends of the tread. The lug grooves are positioned in the contact area without an inside end in the axial direction reaching a circumferential main groove which partitions the contact area. At least one side of the contact area bordering the groove has a ribbed form in the circumferential direction; the other side of the contact area bordering the circumferential main groove is separated into blocks formed by the lag grooves. As the supports for the aforementioned ribbed form prevent the deformation of the join at the position of the lug grooves, sound caused by the acute angled part of the block at time of contact is beneficially suppressed.

[0008] Normally, air flowing into the groove is suddenly expelled outwards causing the problem of a blowing noise. With this invention, the circumferential main grooves are formed by repeating a wide section and a narrow section in the circumferential direction. Circumferential main grooves formed in this way can cause a damper effect, and in this way reduce noise. The tyre tread of this invention has three or fewer circumferential main grooves. The reduction in grooves is counterbalanced by a widening of the groove width, so that the necessary water drainage can be maintained.

[0009]

[Working example] A description based on the diagrams follows. Figure 1 is an expansion plane view showing a working example of the tyre tread of this invention. In Figure 1, there are three or fewer straight circumferential main grooves 2 extending parallel to the tread 1. The tread is partitioned in the contact area by circumferential main grooves 2 and both ends of the tread E, and the contact area 3 is divided in the circumferential direction by lug grooves 4. Regarding this working example, the central groove 2_1 of the circumferential main grooves is positioned on the equator plane 0. The shoulder groove 2_2 divides the relatively wide central contact area 3_1 and the narrow shoulder contact area 3_2 at a point approximately 2/3 distance from the equator plane 0 across the tread. Lug groves 4_1 in the central contact area 3_1 are at a steep angle in the axial direction. The angles in the direction of the equator plane 0 gradually increase and taper, and in this way partition the contact area 5. The shoulder contact area 3_2 has tread

ends E at a small angle in an axial direction. Shoulder lag grooves 4_2 of almost the same width are slightly curved and partition the contact area 5. The explanatory diagrams omit to show that the tyre of this invention has sidewalls which are connected, in a radial direction, with both ends of the cylindrical crown, and this crown section has tread 1. The structure is strengthened by an unextendable belt layer between the carcass, for example a radial carcass extending from the sidewall on one side through the crown section to the sidewall on the other side, and the tread.

[0010] The lug grooves 4 of this invention are positioned in the contact area 3 with the ends in an axial direction not reaching the circumferential main groove partitioning the contact area. Namely, the central lug grooves 4_1 extend from the shoulder circumferential main groove 2_2 and stop before reaching the central circumferential main groove 2_1. In this working example, the central lug grooves 4_1 extend to the narrow circumferential supplementary groove 6 which is relatively close to the central circumferential main groove 2_1 forming the independent block pattern contact area 5, and the rib 7 which is formed in a continuous circumferential direction between the central circumferential main groove 2_1 and the supplementary groove 6. Concerning the shoulder contact area of one side, the extending shoulder lug grooves 4_2 from the end of the tread E stop before reaching the shoulder circumferential main groove 2_2 leaving the constricted part 8, and forming the comb tooth-shaped contact area 5.

[0011] In this invention at least one of the circumferential main grooves 2 is formed by repeating a wide section and a narrow section in the circumferential direction. Figure 2 uses a partial enlarged view to show the central circumferential main groove. The central circumferential main groove 2_1has peaks 9 protruding from its width at intervals, and troughs 10 between them. The wide sections 11 and the narrow sections 12 correspond to the peaks 9 and the troughs 10. In this working example, the left and right of the groove wall has a pitch variation of approximately ¼ in the circumferential direction. Sections with the left and right tips of the peaks are the widest, and a correspondingly wide section is formed between them (approximately ¼ pitch length). The average groove width W_G is 4-8% of the tread width W_T. The optimum corresponding distance d between the peaks and the troughs in relation to the reference line m is within the range of 5-30% of the average groove width W_G. In this working example, the shoulder circumferential main groove 2_2 has wide sections 11 and narrow sections 12 corresponding to peaks 9 and troughs 10. In Figure 1, number 13 represents dimples extending in the direction of the lug grooves, while number 14 represents sipes extending in the same direction.

[0012] Figure 3 uses a partial enlarged view of the circumferential main groove of the second working example of this invention. The special feature of this working example is that the peaks 9 and the troughs 10 are at approximately the same position to the left and right in the circumferential direction. Consequently, the wide section 11 is positioned between the left and right peaks 9, while the narrow section 12 is positioned between the identically positioned left and right troughs 10. In the tread 1 shown in Figure 1, the lug grooves 4 to the left and right of the equator plane 0 and also the contact area 5 are arranged in a point symmetric manner, but the left and right lug grooves can also be positioned in a plane symmetric manner relative to the equator plane. Namely, there is a herringbone design block pattern in the left and right central contact area 3_1. A rotating direction of the tyre has been arranged so that the acute angled inner side of the axial direction of the contact area makes contact with the ground before the obtuse angled

section. When moving, support is received from the circumferential ribs close to the narrow circumferential supplementary grooves and the acute angled parts of the blocks are established to suppress the knocking noise on the road surface.

[0013]

[Results] To determine results for the tyre of this invention, 235/60R16 size radial tyres were used, and, alongside a comparative example, tests for sound and wet skid properties were conducted inside on a test vehicle and evaluated. Tyres used for the working example used the tread shown in Figure 1. Tyres for the comparative example fundamentally used the tread shown in Figure 1, but the whole of the circumferential main groove was straight, the circumferential supplementary groove 6 in the central contact area 3_1 was omitted, the central lug grooves 4_1 were extended in the axial direction to the circumferential main groove 2_1, and the shoulder lug grooves 4_2 in the shoulder contact area 3_2 were extended in the same way to the shoulder circumferential main groove 2_2, so that the entirety of the contact area was formed by independent blocks. However, tread negativity ratio of 34% was the same for both the working example and the comparative example.

[0014] The test tyres had 16 x 7½J rims and an internal pressure of 1.85 kgf/cm^2. The sound test took place in a soundproofed room with the tyres rotating on a smooth drum under a load of 570kgf. The microphones were fixed at a position 75 cm above the drum and 100 cm in an axial direction from the tyres. The test results are shown in Table 1.

[Table 1]

	40 km/h	60 km/h	80 km/h	100 km/h	Mean
Working example	69.7	76.4	81.0	84.7	78.0
Comparative example	72.4	78.9	82.5	86.7	80.1

Unit: dB

[0015] For the wet skid test, the tyres' internal pressure was adjusted to 1.95kgf/cm^2. Water with a depth of 10mm covered a specially constructed concrete paved road with a circular arc 100m in radius drawn on it. The vehicle was driven along this road at various speeds, and the speed at which the vehicle's transverse speed became 0 was determined. The determined results were 85km/h for the working example and 84km/h for the comparative example.

[0016] The tread of this invention is partitioned in the contact area by straight circumferential main grooves and the contact area is divided in the circumferential direction by lug grooves. The lug grooves are positioned in the contact area without an inside end in the axial direction reaching the circumferential main groove which partitions the contact area, and at least one of the circumferential main grooves is formed by repeating a wide section and a narrow section in the circumferential direction. Tyres with tread formed in this manner have high results for noise reduction and no discernable inferiority regarding wet grip.

[Brief explanation of diagrams]

[Figure 1] Expansion plane view of tread of first working example.

[Figure 2] Partial enlarged view of circumferential main groove of Figure 1.
[Figure 3] Partial enlarged view of circumferential main groove of second working example.
[Explanation of numbers]
1 Tread
2 Circumferential main groove
3 Contact area
4 Lug groove
11 Wide section
12 Narrow section

[Figure 1]

[Figure 2]

[Figure 3]